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The ATAIR - a survey, wreck-search and research vessel

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THE "ATAIR" - A SURVEY, WRECK-SEARCH AND RESEARCH VESSEL

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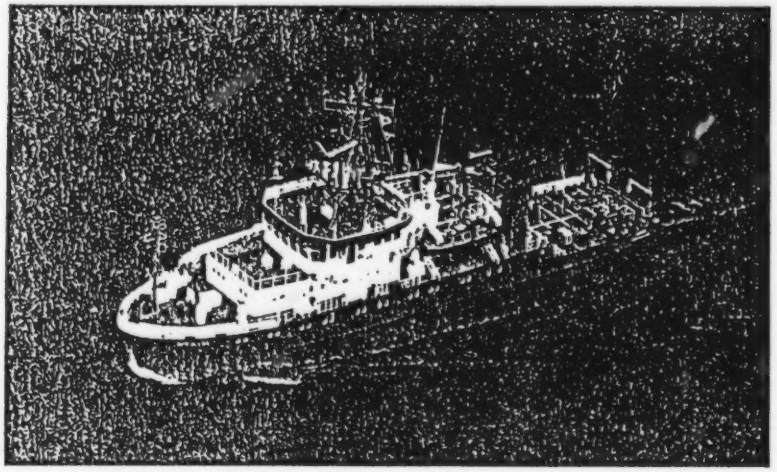
H. Dobinsky[2], K. Hoffmann[2], B. Linke[2] and G. Sosna[2]



The shipyard Kröger-Werft in Rendsburg delivered the survey-, wreck-search- and research-vessel "Atair" to her owners Deutsches Hydrographisches Institut (DHI, German Hydrographic Institute), Hamburg, on the 3rd of August this year after nine months construction time from keel-laying. The newbuilding is rather specially equipped for different duties. 200 dys per year "Atair" will be used for survey- and wreck-search-services, the other 100 days at sea are used for various tasks, e.g. tests of nautical equipment, oceanographic research etc.

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[1] From the Deutsches Hydrographisches Institut (DHI) (German Hydrographic Institute), Hamburg

[2] From the Zentralstelle für Schiffs- und Maschinentechnik (ZSM) (Central Agency for Marine Technology and Mechanical Engineering), Hamburg

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On 3 August 1987, the "Atair", a new survey, wreck-search and research vessel (Newbuilding No. 1521, from the shipyard of Kröger GmbH and Co. Werft KG, Schacht-Audorf) was put into service by Prof. Dr. Gerhard Zickwolff, President of the Deutsches Hydrographisches Institut (DHI) (German Hydrographical Institute), Hamburg, in the course of a demonstration run conducted in the Baltic. The new "Atair", which took nine months to build from keel-laying to completion, replaces the old wooden wreck-search vessel of the same name which was sold to Sweden after 25 years of service.

Because the vessel must meet a wider range of more stringent operating specifications, it is larger than its predecessor. In addition to the principal task performed by the old "Atair", namely searching for wrecks, the new vessel will also be used for survey and research purposes. The aim of the designers was to come up with a compact and seaworthy vessel of moderate draught and capable of operating in the North Sea and Baltic areas. On-board accommodation, work rooms and equipment were all to be fully compatible with modern requirements.

The order for the vessel was placed by the German Hydrographic Institute (DHI), and the design, supervision during construction, and acceptance testing were the responsibility of the Zentralstelle für Schiffs- und Maschinentechnik (ZSM) (Central Agency for Marine Technology and Mechanical Engineering); in performing its tasks, the latter agency was able to draw on the wealth of experience which it has accummulated in the construction of special vessels incorporating

sophisticated technology, such as the research vessels "Poseidon"[3], "Gauss"[4], "Polarstern"[5] and "Meteor"[6]. The planning was carried out in close cooperation with the DHI which has a great deal of practical experience with vessels and work of this type and was therefore able to define a precise requirement profile.

OPERATIONAL DUTIES OF THE VESSEL

Marine surveys and wreck-searching

Marine surveying is one of the tasks with which the DHI has been entrusted by law (see the Act governing the Responsibilities of the Federal Government in the Area of Ocean Navigation). Marine surveying, which also includes searching for wrecks, is carried out in German territorial waters in the North Sea and Baltic and on the German part of the Continental Shelf.

The marine surveys generate working maps (approximately 50 maps of the North Sea, on a scale of 1:20 000, each with 10 000 depth indications; and approximately 70 maps of the Baltic, on a scale of 1:5 000, each with 6 000 depth indications) which provide the basic data for the production of sea charts in this area. In German coastal waters and traffic separation areas, as well as on deep-draught routes, control

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[3] See "HANSA" No. 17/1977, p. 1521

[4] See "HANSA" No. 22/1980, p. 11731

[5] See "HANSA" No. 6/1983, p. 405

[6] See "HANSA" No. 12/1986, p. 1001

measurements have to be carried out at regular intervals ranging from five years to a few months, in order to detect any topographical changes in the sea bed and thus any changes in depth. Oceanographic surveys are conducted for the purpose of drawing special maps, e.g. for fishing and for marine and deposit research purposes.

Searching for and checking the position of wrecks in German coastal waters is another important task which is necessary to keep the sea lanes safe. Using special vessels like the new "Atair", new wrecks (approximately 30 per annum) are located and the more than 1 000 wrecks and underwater obstacles which have already been identified and recorded in the North Sea and Baltic are checked. Because of tidal flows or changes in the sea bed, the position of these wrecks and obstacles may constantly change, and they can thus became an underwater obstacle to shipping.

In addition to the mother ship, two survey boats and one rubber dinghy are used for the marine surveying and wreck-search activities. One of the two survey boats and the rubber dinghy can also be equipped for use by divers carrying out searches for wrecks. The "Atair" is the first DHI vessel which can carry out surveying and wreck-searching simultaneously.

Oceanographic studies

The Oceanographic Division of the DHI uses the new "Atair" mainly in connection with the monitoring and prevention of marine pollution.

While the research vessel "Gauss", which can carry 12 scientists, is accordingly used more for multidisciplinary tasks, the "Atair", which has accommodations for 7 scientists, is used mainly for studies in one particular discipline which can also usually be completed within one week.

The schedule for 1988 includes operations to monitor the radioactivity in the German Bight and the Baltic, two trips to monitor sediments for toxic pollutants, also in the North Sea and Baltic, and three trips to measure the oceanographic parameters in the German Bight.

Up to now, because of the frequently unfavourable weather conditions, it was particularly difficult with the small wreck-search vessels available to service the equipment carried on the North Sea buoy "NSB II" and on the "Nordsee" (North Sea) research platform. Such work frequently had to be prematurely discontinued because the seas became too high for these small vessels. The seaworthy "Atair" will now be used (at least three times in 1988) for this work as well. This will considerably improve the reliability of the remote transmission of oceanographic measurement data from buoys and platforms.

In addition, the "Atair" will be used to deploy or recover equipment which has been anchored in the sea for long periods of time, e.g. depth gauges or current metres. The new "Atair" can carry out magnetic and seismic measurements because there is sufficient space and on-board power capacity to operate even large equipment; as a result the vessel

can provide better scientific back-up for the wreck-searching and surveying tasks which it has taken over from the old "Atair".

While the old "Atair" was a non-magnetic wooden vessel, and therefore better suited for magnetic measurements, in the case of the new "Atair" larger lengths of cable have to be used to permit measurements to be carried out without disruption by the magnetic field of the vessel itself. In the "Atair" the DHI has a tailor-made tool for carrying out observations at sea; and with this vessel it should be able to perform its tasks in the field of environmental monitoring, and also provide support for navigation in the North Sea and Baltic, much more effectively and efficiently than was possible in the past.

Technical analysis and type testing of nautical instruments and equipment

Nautical installations, instruments and items of ship's equipment will be tested on board to determine their safe function and their suitability for operation at sea. Once they have passed the type testing procedures, industrially manufactured nautical installations, instruments and equipment will be certified for use on board vessels. The mounting and positioning of navigation lights, magnetic standard compasses and magnetic steering compasses, also of radio location installations and integrated navigation systems must be approved. In addition to laboratory tests and other land-based procedures, the type testing and approval of the mounting and positioning of such equipment requires that tests be carried out at sea.

Thanks to its size and layout, the "Atair" is a particularly efficient means of testing parts of the nautical systems, instruments and equipment which, according to the Regulations governing the Safety of Life at Sea, must be carried by all vessels. When the "Atair" was built, particular attention was paid to the needs for carrying out practical tests with acoustical signalling installations (in this case whistles) on marine and inland vessels; this was done by installing a platform on the wheelhouse top on which up to six whistles can be simultaneously mounted and operated. Specially designed transportable distribution systems for electric power and compressed air are used so that whistles of entirely different design can be operated and their respective effectiveness can be compared out at sea.

In future, the "Atair" will be used to carry out the following tests on navigation lights:

- Comparison of the brightness of non-electric navigation lights used in marine navigation and signalling lights used in inland navigation, with the results of laboratory measurements

- Changes in the luminous [visibility] ranges and colour of navigation lights and signalling lights, as induced by environmental influences

- Comparison of navigation lights and signalling lights having different electrical light sources (incandescent lamps, halogen lamps, fluorescent lamps)

- Luminous interference between navigation lights and signalling lights arranged above each other

- Visual interference in the observation of signalling lights, caused by flash discharge lamps

- Observations of signal lights under various weather conditions

- Determining the visual range of navigation lights and signal lights

- Determining the visual range of rescue lights (life-saving lights)

- Perceptibility and recognizability of rescue lights (life-saving lights)

- Determining the visual range of Morse and maneuver signalling lights.

The "Atair" is also suitable for carrying out shallow-water measurements when type testing echo sounding equipment, also for testing radar reflectors for use on life-saving equipment, and for testing distress radio buoys.

DESCRIPTION OF THE VESSEL

The shape of the hull should satisfy the following requirements:

- Smallest possible draught for carrying out survey work in tidal flat areas

- Must be suitable to permit the vessel to sue (take the ground) in tidal flat areas

- Optimally designed foreship to permit the use of sounding equipment.

Because of the latter requirement, it was decided not to provide a bulbous bow in order to minimize the amount of air entrained into the water. To permit the installation of the numerous underwater oscillators and other items of equipment, it was necessary to create a sufficiently large, flat bottom ahead of the Schottel pump jet. For this reason, a stern post, having a vertical and sharp underwater section with rapidly widening water lines, was selected. According to the operating experience gained so far, excellent sounding results have been obtained. It is possible to take soundings even in bad weather.

A flat bottom was provided in order to permit the vessel to take the ground. In order to improve the propulsion characteristics, a nozzle has been installed to compensate for the local velocity of the current flowing towards the propeller. In addition, the designers selected a broad square [transom] stern in order to permit large working deck areas and container storage spaces.

The dimensions of the fuel oil and fresh water tanks, as well as the storage facilities for other supplies, were selected in such a way that

Fundamental Data Relating to the Ship

Length overall	51.50 m
Length between perpendiculars	47.20 m
Frame width	11.40 m
Moulded depth to main deck	5.25 m
Draught	3.18 m
Deadweight-carrying capacity at this draught	164 t
Measurement	950 BRZ/285 NRZ/915 BRT
Speed under trial run conditions	11.6 kn
Power required for the above speed	660 kW
Accommodation for a total of	23 persons
(Number of crew	16 persons
Number of persons carried in addition to crew	7 persons)

Class: German Lloyd 100 A4 M (short international voyages) E MCE Aut

Radius of operations: "short international voyages"

Ship's bottom reinforced to take the ground: P_B max = 65 kN/m²

the vessel can remain fully operational at sea for a period of up to two weeks. In addition, it is possible to carry 20 t of scientific cargo and two containers can be stored on deck. The working rooms and laboratories, winches and lifting gear as well as the working deck were all arranged to meet the given requirements and tasks to be performed. A multi-purpose space with a hatch leading to the main deck, which can be used either as a storage space or a workshop, has been provided below the lower working deck.

Hull design

The hull is of conventional transverse frame design. The ship's bottom was reinforced to permit it to take the ground at a maximum ground pressure of 65 kN/m². The transom (12 mm) and the shell plating on the starboard side (10 mm) were reinforced in order to ensure that no damage would be caused when carrying out work over the side using heavy equipment.

The working deck is covered with a grid system (grid dimensions 600 x 1650 mm) of flush-mounted screw bushings having an M 24 thread. These threaded bushings are combined with welded-on T-rails which at the same time secure the wooden wear deck. For the purpose of determining the strength, it was assumed that each transverse rail would be exposed to a moving point load of 50 kN, which was taken to be a realistic load stress for all operations. By means of this grid of bushings let into the deck, which is present on all modern research vessels, it is possible at any time to attach winches and research equipment, deflector pullies, etc. To accommodate larger winches, an intermediate foundation frame covering six attachment points in the grid (= 1650 x 1200 mm) is also supplied.

Fixed equipment

The ship was provided with specially reinforced bow and stern anchoring equipment (Hatlapa), because when the vessel is carrying out surveying, wreck-search and research missions, it sometimes has to remain anchored for a long period of time in unprotected waters.

The bow anchoring facility consists of:

- Electrically powered double winch with 2 capstan barrels
  Rated chain tensile forces and speeds 50/50/16 kN at 3.7/15/45 m/min
  maximum chain tensile force 100 kN

- 2 roller bowstoppers [chain stoppers], rated breaking load 642 kN

- Stud-link chain cables, 28 mm in diameter, K 3

- 2 De'Hone anchors, each weighing 1000 kg, marine design, carried with a low centre of gravity in anchor pockets.

The stern anchoring facility consists of:

- An electrically powered cable windlass with one capstan barrel
  Rated tensile forces and speeds 50/50/16 kN at 3.7/15/45 m/min
  250 m of wire rope, 24 mm in diameter

- One De'Hone anchor weighing 1000 kg, carried like the bow anchors in a well-rounded anchor slide.

Double bitts (bollards), hawses, deflector pulleys and a 30 kN warping capstan, are appropriately arranged to permit the ship to be warped and made fast.

Maneuvering

The wide range of operational activities calls for optimal maneuvering characteristics. The vessel was therefore fitted with a high-performance fin rudder (Hinze) which requires 9 sec to move from one hard-over position to the other (hard-over setting in each case 45°). In addition, a pump-jet (Schottel) having an infinitely variable 400 kW electric drive system was installed. The maximum thrust force in all directions is 345 kN. The pump-jet consists of a volute housing rotatable through 360° and containing an impeller which draws in water from below the ship's bottom and forces it out again as a thrust jet. The unit is installed flush with the bottom of the vessel, it requires very little water, and it is therefore particularly suitable for shallow-water operation.

Using the pump-jet alone, without the main propulsion system operating, it is possible to achieve a speed of 8.0 kN. When operating on station, frequently only the pump-jet is used. This avoids the danger of lines becoming entangled in the propeller and rudder. Experience gained so far has demonstrated that the pump-jet does not have any effect on the taking of soundings. This means that the taking of soundings during on-station operation is not interrupted by the maneuvering aid, although the water jet does pass over the area of the oscillators.

Stabilizer

An Intering stabilizer has been installed as an anti-rolling device. This installation was selected because, regardless of the speed, the roll-damping moment available is the same at all times. The tank is filled with saturated potassium carbonate solution (which means smaller tanks and a corresponding saving of space), having a specific weight of 1.55 tm^3 and a stabilizing moment of 59 mt. The system is effective through a roll period range from approximately 8.8 to 15 sec. It works very satisfactorily, and in general the roll angles are approximately halved. It does not generate any disturbing noise.

The following life-saving facilities are provided:

- A stand-by rubber dinghy with outboard motor, which is lowered by means of a combined raft-lowering/hydraulic victualling crane (Davit International)

- One life raft on the port side and another on the starboard side, packaged in a container under a launching device

- One life raft on the port side and another on the starboard side, packaged in a container on top of a launching device swivelling outwards

- 23 survival suits with thermal protection

- Life rings, etc., in accordance with the regulations

Special equipment

The following lifting gear, special winches and other special devices form part of the standard equipment of the vessel:

Central work crane

The crane (produced by the Neuenfelder Maschinenfabrik) is dimensioned as a supplies crane for carrying out work at sea, H/3 = 2.0 m (significant wave height), Vw = 1.2 m/s, wave period 5 sec, with swan-neck gib.

Lifting capacity (SWL):

4 800 kg; as victualling crane: 3 300 kg

Working radius:	2.4-12.5 m
Lifting speeds	
- up to SWL 4.8 t:	0-45 m/min
- empty hook up to 1.0 t:	0-60 m/min
Hoisting rope length:	40 m

The long length of rope was provided to permit the use of large box-type grab buckets in shallow water areas. To protect against overloading, an adjustable slip clutch was installed which opens at a load of approximately 60 kN.

Outrigger

The outrigger (Hatlapa) is used to guide the deflector pulley blocks for the single-core rope* and the standard rope. The outrigger which is of frame-shaped design, is arranged over a cut-out in the deck which permits the raising and lowering of water scoops (arranged in annular arrays). The boom was dimensioned according to the breaking load of the single-core cable*, namely 42 kN, and it can be infinitely swivelled by means of hydraulic cylinders (working range outboard and inboard: 1.5 m in each case). Allowance has been made for an angled tow of 75° aftwards and forwards, as well as 45° to the side. (Laterally).

Slewing davit for the wire winch

A slewing davit (Davit International) is installed on the starboard side, at the after edge of the forecastle deck, to accept the rope guide pulleys of the wire winch and to lower and recover research equipment over the side of the vessel:

- SWL 30 kN
- Oblique pull 30°
- Infinitely pivotable under load; can be hydraulically locked in any position
- Height of hook in swung-out position: 3.0 m over forecastle deck

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*Literal translation.

- Pivoting time from stop to stop: 20 sec
- Pivoting range inboard and outboard from the side of deck: 2 m in each case
- Sensitive remote control

Towing davits

It was deliberately decided not to install a gallows frame at the stern. Instead, two towing davits (Davit International) were arranged on either side of the stern to carry out towing operations, recover equipment, etc.

- SWL = 3 t
- Height of hook above deck = 2.0 m
- Drive system: self-blocking worm drive, handed-operated
- Oblique pull = 80°
- 3 t rated elongated spectacle eye and fishery tackle block (short type)
- Working range 1.5 m
- Mechanically locked by bolts which can be inserted at 8 different positions

Single-core cable and standard cable winch

On the starboard side of the boat deck, behind the outrigger, is located the winch for the single-core and standard cable (Hatlapa) it is designed as an electro-hydraulic double winch.

- 600 m single-core cable, 8.2 mm in diameter; with coiling gear
- Rope speed (middle lay) 0-115 m/min
- Tensile force (middle lay) 8.5 kN
- Sensitive remote control
- Facilities for measuring rope length and rope speed
- Standard rope drum 160 mm wide; without coiling gear
- 200 m standard wire, 6 mm in diameter
- Measuring block for indicating rope length

Wire winch

The electrically powered wire winch (Hatlapa) is located on the port side on the working deck; it can be used via the pivoting davit, the towing davits or directly via the rounded transitions from the working deck to the skin plating (starboard side) or to the transom.

- Length of rope/cable = 250 m, 18 mm in diameter
- Rope speeds 3.7/15/45 m/min
- Tensile forces 30/30/10 kN
- Electronic rope length measuring device in the coiling gear.

Extendable arm

An extendable arm (Hoppe-Bordmeβtechnik [Hoppe Shipboard Measuring Technology]) model NW 150, is installed in the compartment containing the bottom-measuring equipment, bow thruster, and sounding equipment. The device is used for deploying probes and/or for drawing in sea water.

- Extended length: 600 mm
- Diameter of extending tube 125 mm
- Electro-hydraulic drive with operating and monitoring panel mounted in the bridge and in the compartment itself.

Trunk for radiation measuring probe

The aforementioned space also contains a special trunk housing a radiation measuring probe for continuously measuring radioactivity.

Working boats and davit installations

Working boats

The "Atair" is equipped with two working boats (built by the Fassmer yards) which are extensively fitted out for marine and coastal survey work as well as for diver support operations.

A description of the boats together with their equipment can be found in "HANSA" No. 18/1987, p. 1070. It can be added here that the following criteria were considered when designing the boats:

- Good stability including at planing speed
- Good steering capabilities including good characteristics when moving astern

The following results were obtained during trial runs:

- Survey boat: weight = 3.525 t (including 50% stock of stores and two-man crew)
  a) power output 132 kW/3500 min^{-1}: 22.8 kn
  b) power output reduced for working operations 110 kW/3200 min^{-1}: 19.1 kn

- Diver support boat: weight = 3.825 t (including 50% stock of stores and two-man crew)
  a) power output 132 kW/3500 min^{-1}: 22.2 kn
  b) power output reduced for working operations 110 kW/3200 min^{-1}: 18.9 kn

Davit installation

The boats are lowered and recovered using an electro-hydraulically operated davit installation (Davit International). The davit in question is of the gravity type and has the following special features:

- Winches which can be separately operated for the front and aft boat lines, and which can be operated like a conventional boat winch when coupled with the centrifugal brake for lowering the boats in an emergency

- Hoisting and lowering speeds 0-60 m/min

- Pay-off rollers on the davit heads prevent any slack building up in the rope

- The winches respond to the sea state in the hoisting direction, i.e. any slack in the rope caused by the movement of the sea is hauled in at a rate of 150 m/min.

- In order to reduce dynamic impacts, a spring extendable to 750 mm with an adjustable nitrogen damping cylinder has been provided

- Hydraulic rapid lashing capability for the boats consisting of two pairs of tongs which grip a round steel bar on the boat at deck height, and two swivelable keel blocks.

Fittings, special rooms and compartments, sound insulation

Fittings

The rooms and compartments used for accommodating crew and non-crew members are arranged on the 'tween-deck, the main deck and the forecastle deck. Provision store rooms and refrigerated rooms are located on the 'tween deck ahead of the accommodation area. The crew members are housed in single rooms while non-crew members are housed in single and double rooms sometimes with a folding bunk. The necessary sanitary facilities can be easily reached from the accommodation areas. The interior of the ship was conventionally finished using Resopal laminated panelling.

The wheelhouse, which is located approximately midships, offers a good panoramic view and from the wing of the navigating bridge it is possible to keep a close watch on the lines leading into the water on the starboard side during winching. The wheelhouse is subdivided into the following working areas:

- Bridge control stand with deck console containing all the necessary equipment for controlling the vessel

- Navigating map table

- Map table with additional working area and an operating terminal for the data distribution system

- U-shaped survey control stand with surveying installation including echo sounder (for survey purposes) as well as an echo ranger [horizontal echo sounder] and side-scan sonar for wreck searching

- Radio corner

- Control positions in the wing areas of the navigating bridge

Special rooms and compartments

The special rooms and compartments listed below are provided to take account of the varied operational role of the vessel. The furnishings meet the standards which apply to modern research vessels. They are attached to the walls using a C-rail grid and can thus be easily

replaced and exchanged if the space has to be converted for a special role. The rooms and compartments used for scientific purposes contain data monitors, data hook-ups, separate power supply circuits and also their own intercom system. In addition, where necessary, connections are provided for hot and cold water, sea water and compressed air for laboratory use.

Surveying and working room

The room is located beneath the wheelhouse and contains the interpretation equipment required for carrying out survey work, including a DIN A O plotter. Work areas and a 19 inch cupboard are provided for the exclusive use of scientists working on board.

Wet work room

The room is located on the starboard side on the main deck and access to it is gained via a large double wing door. The following fixed installations are provided: a fume cabinet, an acid-handling basin with corresponding drainage facilities, three laboratory workplaces, a refrigerator and a hydrographic installation. If needed, a centrifuge can also be set up here. The space outside in front of the double door is sufficient for storing one array of water scoops.

Dry laboratory

This laboratory is provided as a dry measurement area for use in conjunction with the wet laboratory. It contains two laboratory

workplaces, an acid basin, a deep freeze, a swinging table and additional cupboard space. It was deliberately decided not to provide an exit to the outside.

Diver-support room

The room is situated on the port side and from it access can be gained to the working deck via an extra-large double door (for installing and removing the pressure chamber). All necessary facilities for diving operations, such as decompression chamber (Haux) with compressed air and oxygen supply system, compressor, diving equipment (Dräger), hoses, diving suits and work bench are included in this room. For reasons of space, a one-man pressure chamber used for transportation purposes is carried on the wheelhouse top.

Container hook-up room

This room is located at the rear edge of the deck house in the immediate vicinity of the container storage points and contains all the power, communication and data hook-ups required to serve the laboratory containers. The water and compressed air connections are grouped together in a niche in the deck house.

Electronics workshop

This is centrally located in the vessel alongside the surveying and working room and it has been equipped with all the necessary measuring

equipment as well as with an extensive stock of standard electronic components. The onboard electronics technician is thus able to carry out repairs and maintain on-board operations without any assistance from shore.

Sound insulation

In a vessel of this type, it is a prime requirement to ensure particularly low sound pressure levels in the area of the working rooms, the accommodation areas and on the open decks; also, in particular, it is important to avoid the emission of sound below the water line.

During the planning phase of the vessel, extensive studies were undertaken by a firm of insulating specialists, Kaefer Isoliertechnik, and by the acoustical advisory company Müller BBM. The three-phase generating sets were elastically mounted under a sound insulation cover using an intermediate base frame. The air inlet and outlet openings are fitted with sound insulating baffles. All the auxiliary equipment, the hydraulic installations for the double winch and the boat davits, as well as the pump jet, including the associated tubing and piping, were elastically mounted.

The walls and ceilings of the engine room and of the utility spaces were fitted with sound insulation material covered over by perforated metal sheeting. Floatingly mounted steel floors were installed in the 'tween-deck, in the aft cabins on the main deck and in the dry

laboratory. The other areas were fitted with Semtex floors - in some areas 2 mm thick metal plates have been bonded to the floors. All ceilings and walls were elastically mounted. Double walls have been arranged between the living quarters.

The prescribed sound pressure levels have been maintained in all areas, even with the pump-jet in operation.

Propulsion machinery

The propulsion system used in the "Atair" is designed for an unmanned engine room according to the category GL AUT. As in the case of other vessels with similar roles, the decision was taken to equip the "Atair" with a diesel-electric drive system.

Engine installation

The two DC generators required for the propulsion system and the onboard power supply are each driven by a water-cooled DEUTZ MWM four-stroke marine diesel engine type TBD 504 BL6, with intercooled supercharger, and each having an output of 463 kW at 1500 rpm. In this series of engines the continuous running at low loads which is required for on-station operation is achieved by means of butterfly valve controls in the cylinder head inlet duct in order to achieve optimum combustion.

The motor and generator units are mounted on a common base frame and joined together by a highly elastic RATO coupling. Each base frame is

in turn mounted on four Cushymount rubber elements in order to provide optimum vibration damping.

The generator used to provide power while the ship is in port is coupled with an air-cooled DEUTZ diesel motor, type BF6L 513 R, having an output of 103.8 kW at 1500 rpm. The motor and generator are mounted in a double-elastic manner.

The three aforementioned diesel units are jointly installed in a sound-insulating cabin. The elastically suspended exhaust gas lines are vented to the exterior via effective silencers through the exhaust posts arranged on the port side. A fourth air-coooled DEUTZ diesel engine, type F1L511, having an output of 10.6 kW at 3000 rpm, is installed as a stand-by unit with generator in the stand-by generator room on the forecastle/boat deck.

Propeller shaft and propeller

The DC propulsion motor drives a 5-bladed solid propeller having a diameter of 1900 mm, via a thrust bearing with a bearing-mounted intermediate shaft and an oil-lubricated propeller shaft mounted in white metal bearings. All the shaft couplings and the propeller unit are designed for hydraulic assembly.

Fuel oil and lubricating oil system

The entire fuel oil system is designed for gas oil operation. The fuel oil day tank is arranged in the sound-insulating cabin and is

automatically filled by a CJC filter separator. Oil can be pumped back and forth between all the fuel oil storage tanks by the fuel oil pump if this is required for trimming the vessel. A second filter separator is installed for the refuelling system used on the measuring/surveying and diver-support boats.

Each diesel engine is equipped with its own attached lubricating oil systems. Automatically operating, electrically driven pre-lubricating pumps are provided for each of the two main diesel engines.

Cooling water system

All heat-producing units on board are cooled by a regulated freshwater circulating system employing box-type heat exchangers suspended in sea chests.

Each main diesel engine has its own independent single-circuit cooling system with attached cooling water pumps and one sea water-immersed heat exchanger per unit. A heat exchanger is arranged in each cooling circuit to permit the cooling water to be used for heating purposes, or the system can be automatically switched over to pre-heat the diesel engines from cold after they have been shut down.

A branched low-temperature cooling system circuit is available to serve the other heat-producing units on board, such as:

- Propulsion motor

- Main generators
- Electric motor of the Schottel pump-jet
- Thrust bearings
- Hydraulic oil coolers
- Food refrigerating machinery

The individual units are supplied by two electrically powered cooling water pumps (and one stand-by pump).

Bilge water and ballast system

The bilge pump system is designed according to the latest MARPOL specifications and comprises:

- Bilge water oil extractor, 0.5 m^3/h
- Bilge water collecting tank
- Dirty oil and waste oil tanks
- Combined bilge water and ballast water piston pump, 30 m^3/h at 2 bar
- Combined bilge water/ballast water and fire pump, rotary type, 25/30 m^3/h at 4.8/2 bar

All the ballast water tanks are designed in such a way that water can be pumped from one to the other.

Heating and ventilation system

The combustion air required by the engines and the radiant heat to be removed from the individual heat-producing units is ducted into the

machinery and engine room via two axial-type fresh air fans. The waste air escapes naturally via the exhaust posts. The auxiliary machine room is ventilated by means of a separate fan. An air-cooled air conditioner is installed in the engine control room.

Four air temperature control systems (manufactured by the firm of Noske-Kaeser) supply air and heat via regulated vent (Regovent) systems to the accommodation spaces and mess rooms, kitchen, laboratories, workshop and stores. The system serving the accommodation and mess room/day room spaces is designed so that it can be expanded at a later date to include an air conditioning system. An efficient air exchange is provided by 11 exhaust air systems.

The primary heating system for the vessel is a pumped hot water system. All the cabins and rooms are fitted with thermostat-controlled radiators. The system can be operated via the oil-fired boiler or using the cooling water heat exchangers referred to above, or a combination of the the two is possible.

Compressed air system

A compressed air system operating at 10 bar, with a compressor having an output of 35.5 m^3/h and a buffer-type air bottle of 750 L capacity, is provided to serve the scientific sector, the on-board technical facilities, and the INTERING stabilizer tank system.

Sanitary waste water disposal

The black water is taken to the waste water treatment facility via a vacuum system with buffer tank, having an output of 6.6 m^3/day. The grey water is conducted into the waste water treatment plant via natural gravity; while the galley waste water is passed via a grease filter or a wet waste macerator (garbage disposal unit) and then via a waste water lift system before being discharged into the sewage treatment plant.

Sanitary fresh water system

All points requiring fresh water are served by a pressurized tank system. The fresh water supplies are backed up by a ROCHEM reverse osmosis plant which operates according to the plate membrane principle. The plant produces 3 m^3/day and can be used to desalinate river water, brackish water, as well as sea water. The system is designed in such a way that it adjusts automatically to the constantly changing feed water conditions. Separate modules are used to prepare drinking water from river water/brackish water and sea water. In order to provide the daily requirements at a sea water temperature of 0-25°C, the sea water is preheated by means of a hot-water heat exchanger.

Electrical system

The electrical power-generating system, which feeds an on-board grid supplying not only the on-board grid-connected loads but also the

converter-fed propulsion units, is of the type installed in many of the research and special vessels constructed in recent years. In particular, the German Hydrographical Institute has acquired a wealth of experience with the research vessel "Gauss", which was put into service in 1980 and is equipped with a comparable electrical system. As in the case of the research vessel "Gauss", the power-generating and propulsion systems are controlled from the bridge; it is also possible to select a "harbour operation" mode, which is used during the relatively frequent periods when the ship is at anchor. Steps have been taken to ensure that operating errors and load conditions which might result in a breakdown of the power supply cannot occur.

The company Siemens AG was responsible for designing, supplying and installing the electrical system.

Regular and special shipboard power supply systems

The fundamental layout is shown in the circuit diagram: "Power supply system and propulsion system".

The 380/50 Hz propulsion power system is designed as an ungrounded 3-conductor system with insulation monitoring, having the form of an IT protective system in accordance with DIN 57100 T 310. The system can be separated by means of a tie circuit-breaker into a propulsion power system and a "harbour operations" system.

The steady-state voltage deviations amount to max. 2.5%. The frequency is corrected to 50 Hz by the automatic power supply system. The

system supplies power to the DC motor loads connected to the power supply system and, via converters, to the propeller motor propulsion system as well as to the bow thruster pump-jet motor.

The power is generated by two main diesel generators and a harbour-operations diesel generator. The main generators are laid out for an output of 640 kVA, 100% converter load, and a cos phi of 0.7; the units supplied are model IM 1101 generators with double-pipe coolers. They are connected to the 35°C low-temperature cooling circuit. The harbour-operations unit has an output of 120 kVA at cos phi 0.7; continuous parallel operation of this unit with the main generating units is possible.

The 380/320 V 50 Hz power supply system is designed as a four-conductor system with an earthed star point (neutral point), in the form of a TN-S system in accordance with DIN 571 00/T/310. It is supplied via two 50 kVA transformers from the propulsion power system or harbour-operations power system; to improve the degree of radio interference suppression the transformers are provided with an earthed shielding winding. The low voltage loads, lighting and socket-outlet circuits, as well as cross-overs to the special power supply system and to the emergency switchboard are also connected to this system. In the event of failure of the shipboard power supply system the emergency lighting, position lights and signal lights, radio and radar installations as well as other important power loads can be supplied from a 10 kVA stand-by generator.

The 380/320 V 50 Hz special power supply system is also designed as a four-conducter system with an earthed star point (neutral point). This system supplies power essentially to the laboratories, navigational systems, radio and sounding installations as well as socket outlets for broadcast receivers in the living accommodations. The system is supplied with power via a 35 kVA converter set having a voltage tolerance of ± 1%, or via the crossover from the 380/220 V ship electrical system.

The converter-generator set is powered by a self-starting synchronous motor. An angularly variable coupling, which is adjusted to the phase angle of the ship electrical system, permits changeovers to be made between the two power feeds for the special supply system without interrupting service. It is similarly possible to switch over without any interruption to the ship electrical system if any faults develop in the converter set (overloading, excessive temperature), and this is signalled in the fault reporting system.

The 24 V battery networks are in general earthed. The batteries provided are as follows: one 360 Ah stand-by battery, two 180 Ah starter batteries and one 180 Ah automation battery. The batteries are charged via charging devices having a constant voltage/constant current curve.

For data protection purposes, 220 V AC connections are provided in the laboratory and bridge areas; these are supplied from an uninterruptible power system having a rated output of 1.5 kVA, with a stored energy time of 15 min.

Propulsion system

The propeller is directly driven by a separately excited DC motor having a rated output of 660 kW at 460 V which can be delivered in the speed range of 230-300 rpm. The motor is a Type IM 1205 with a self-lubricated plain bearing; it is equipped with Type IP 44 protection and a double-pipe water cooler which is connected to the 35°C low-temperature circuit. The internal motor cooling circuit is fitted with a micro-type air filter and two pole-changing fans which can be operated at half speed if the full motor power output is not required. Reduced propulsion operation (450 kW) is also possible if one of the fans should fail.

If the cooling water system should break down, propulsion operation can be maintained by opening up air flaps. The cooling system is monitored by two flow indicators. In addition, resistance thermometers are installed for the plain bearing, the main pole winding and the compensating winding; also, a probe with two electrodes is provided to signal any leakage of coolant.

The armature of the motor is powered from the 380 V 50 Hz ship electrical system by two thyristor converters connected in parallel for continuous operation. Both converters are arranged in separate cabinets with integral fans. They are supplied with firing pulses from a common control set so that the power is uniformly distributed between both bridges.

In order to keep the harmonics in the system to a minimum, the number of parallel converter bridges is dependent on the number of generators feeding into the system. If only one of the two main generators is operating, one of the two three-phase bridge connections in the armature circuit is blocked. It is possible to preselect via a switch installed in the auxiliary operating panel.

The field current converter consists of two inverse-parallel connected three-phase bridges. The reversal of the direction of rotation is achieved by field reversal controlled by an auto-reversing module. Two field rectifier sets are available and they are arranged in the main converter cabinets. One set is connected up and operational while the second set is a redundant stand-by unit.

The control system is arranged together with the field-circuit transformer in a separate cabinet and designed in such a way that no artificial ventilation is required. A brief description will now be given of the control system. Control is effected by means of the Siemens Transidyn-C-Principle with secondary control circuits. A distinction is made between the speed control and current control circuits for the motor armature and the voltage and field current control circuits for exciting the motor.

The desired speed is tapped off from a potentiometer installed in the engine telegraph. The desired value is modified as a function of the number of generators feeding into the power system in order to make full use of the control lever travel at all times.

The sign (+/-) of the desired speed voltage determines the direction of torque via the auto-reversing module when the field current converter is selected. The output from the desired-value potentiometer passes via the ramp-function generator in the form of a desired speed value and is fed to the input of the speed regulator. The ramp-function generator is combined with a ramp correction module. In the event that current limiting occurs, the motor speed drops. Because of the large difference between the desired and actual values that would then exist at the speed control input, the speed controller would try to abruptly compensate for the desired/actual difference once the current limiting requirement no longer exists. In order to prevent this, when current limiting occurs the ramp correction module matches the ramp function generator output to the actual speed. Once the current limiting requirement no longer exists, the desired speed is therefore restored at the normal ramp-up rate.

The speed regulator output supplies the current set point for the secondary current control circuit. Therefore all current limiting events act on the output of the speed regulator. Current limiting events of external origin may occur, as a function of the reverse power output or actual power output of the diesel engine, and the generator current. Internal limiting set points ensure that the armature current of the motor or the rated converter currents are not exceeded.

The current set points are tapped off via measuring transducers from current transformers in the DC feed to the rectifier bridges. The

combined total of these two signals provides the signal for the actual armature current to the current regulator.

In the field regulator circuit a distinction must be made between field current regulations and armature voltage regulation. If the motor is operated below the base speed, i.e. with an armature voltage less than the rated voltage, the voltage regulation system is ineffective. The field current (excitation current) is held constant. If the armature voltage exceeds the voltage set at the input to the voltage regulator, the voltage regulation system is activated and initiates field suppression. The speed is regulated up to the base speed of 230 min^{-1} with a constant rated-load excitation via the armature voltage, and from 230-300 min^{-1} with a rated armature voltage via the field-shunting control.

The correct sequence for enabling the regulator and outputting the control pulses when switching the drive on and off is taken care of by the making and breaking control system which also contains all the interlocks for the drive.

Pump-jet drive

The Schottel pump-jet is driven directly via a DC motor having a rated output of 400 kW at 460 V and 1500 min^{-1}. The motor is of the IM 1001 type; it is fitted with IP 44 protection and has a separately driven fan and has a separately driven fan and a GEA double pipe cooler (35°C). The design of the converter corresponds to the converter

system used on the main motor. The control system merely has to take account of one direction of rotation; however, the same current limiting facilities as used in the main propulsion system come into effect to reliably prevent overloading of the power-generating units. The limiting system for the pump-jet motor does not come into effect until the limiting system on the propeller motor cannot by itself provide the desired load reduction.

Communication equipment

Nautical equipment

The nautical equipment and installations provided in the "Atair" have been matched to the role and radius of operation of the vessel. A brief description will be given of these installations in the following. The links with other systems, such as the data distribution system and the surveying system, are shown in the system sketch of the data distribution system (see at end of paper).

The NAVIGAT II gyrocompass installation supplied by the firm of C. Plath is fitted with several repeater compasses, including an LR 40 digital repeater which converts the synchro value into a digital value. The installation also includes an autopilot (model: NAVIPILOT II EL).

The radar installation consists of an X-band and an S-band radar unit of the type SELESCAN 1024/ARPA and SELESCAN 1024/TM manufactured by the

Selesmar company. The terminals are modern daylight-grid-scan units with upright screens. Both terminals can be cross-connected or can be connected as master/slave units.

The navigational receivers used are the RS 4000 unit produced by the firm of Eissing and the MNS 2000 unit produced by the firm of Debeg.

While the RS 4000 unit is a pure Decca receiver, the MNS 2000 set also includes a Loran-C-receiver and a satellite navigator. The receivers are also backed up by a colour plotter (Type RS 2000) for displaying the ship's position. The latter can be obtained either from the RS 4000 receiver or it can be selected as a system position from the surveying installation.

The ship's speed over the ground, including the transverse component, is determined by the Doppler-log DOLOG 22D produced by the firm KAE. The speed through the water is digitally displayed by the EM Log NAVIKNOT II NF produced by the C. Plath company. Both types of speed information can be optionally displayed on the radar terminals.

The WEMPE central clock, with date display, is used not only to control the analogue clocks on board, but it also supplies data to the data distribution system and the surveying installation.

The metereological system supplied by the firm of Theodor Friedrichs, consists of an anemometer and instruments for measuring air and water temperature.

The LAZ 51 type navigational sounder with a type DAZ 13 digital display manufactured by the firm of Honeywell-Elac is installed.

Survey equipment

The surveying equipment consists essentially of the following units:

- Marine surveying system
- Surveying depth sounder
- Horizontal echo sounder
- Side-scan sonar

The SysVerm 310 marine survey system produced by the firm of Feistel-Eckhardt consists of a series 310 Hewlett-Packard computer system with a 1 MByte memory, a 10 MByte Winchester disk, a 780 MByte 3.5 inch diskette, a dot-matrix printer, an A-3 plotter and corresponding interfaces.

In addition, a right-left display is provided to permit the helmsman to steer the ship exactly along a track defined by two way-points. In the North Sea the exact position required for this purpose is supplied to the survey system by the Syledis SR 3 receiver which is connected to it - this procedure will soon also be possible in the Baltic. In areas which are not covered by the Selydis system, the position can also be obtained from the MNS 2000 navigation receiver. In addition, it is possible to connect up other positioning systems such as Polarfix or Miniranger.

The water depth is determined using a type CPV Hydrograph HCPV (survey echo sounder) produced by the company of Dr. Fahrentholz. The standard frequencies are 31 and 210 Hz, but it is also optionally possible to operate at 15 kHz instead of 30 kHz. The sounder has been modified for deep sea application down to a depth of 5,000 m using low frequencies. In each case, two oscillators are provided, between which the system can be switched back and forth. While the oscillators in the foreship area also operate, as expected, in poor weather conditions, this was not necessarily to be expected in the case of the oscillators in the midship area. However, during the trial runs in the Skagarrak excellent sounding results in water depths of approximately 700 m were obtained even with the oscillators in the midship section.

The digitalized water depth measurements are recorded on-line on the Winchester disk together with the position. The position can be simultaneously plotted on the graphics screen and the A-3 plotter, thus providing a complete picture of the distance covered.

The survey equipment carried on both the survey boats is the same as that on the mothership, with the exception of the additional deep-sea modification of the echo sounder. In all cases, a standard 24 V DC power supply is used so that, if needed, the equipment can be changed around.

For initial processing of the measurements, an interpretation system is provided consisting of an identical computer system in the survey room and work room. The computer is based on a storage capacity of 5 MBytes

possesses additional peripheral equipment, i.e. DIN A O-plotter and a 9-track tape recorder. The measured data can be transferred to this system by diskette and can be recorded on the magnetic tape for the purpose of carrying out further processing at the computer centre of the DHI. In addition, initial working maps can be prepared on the A-O plotter.

The FS 3700-CSS horizontal echo sounder produced by the firm Honeywell-Elac is used to search for wrecks. It has been specially modified for this purpose and additionally fitted with a sum/difference facility. This device permits extremely accurate location of the target. Once a wreck has been located and recorded on the echograph as the vessel passes over the site, the size and position of the wreck can be determined with the aid of the side-scan sonar.

This side-scan sonar (Type 260 produced by the firm of EG and G) consists of an underwater component - the "fish" - and a recorder. The "fish" is normally towed on a cable just above the sea bed; but in the "Atair" it is firmly mounted for the first time on an extendable boom. The boom, which is manufactured by the firm of Hoppe, is designed in a manner similar to the boom installed in the foreship and permits a travel of 1 m. In the retracted position, the "fish" is protectively stored in a niche in the hull.

Initial images of known wrecks have yielded excellent results. The outlines of the wreck can be recognized; in addition, it is possible to determine the length of the wreck because the paper feed is controlled

by the DOLOG, thus permitting a true-to-scale plot. The position is determined by the vessel's course, which is recorded on the paper plot together with the position, date and time of day.

Special scientific equipment

For scientific purposes, but also for the purpose of navigation, the ship is fitted with a data distribution system of the type DATADIS-VI manufactured by the firm of Maritec Engineering (see description in HANSA, No. 18/1987, p. 1071). This system permits the user to read off at a glance all the relevant nautical data from one screen in various rooms. Several ready-made formats are available for this purpose; in addition, some customized formats can be developed if desired to meet the respective requirements. A choice can be made of the following parameters: size of font (single, double and 3.5 x), position on the screen, and also the associated attributes (normal, inverted, flashing and underlined).

In all rooms where there is a screen hook-up, a data socket is also provided. All the data recorded are attainable in the form of a serial telegram from these data sockets with a repeat rate of 1 second, and they can be recorded by the user. The equipment of the data distribution system is rounded out by a printer.

One special feature should be mentioned, namely that the data distribution computer is fitted with an internal battery back-up so that the current memory contents are retained in the event of power

failure or when the unit is switched off, and the computer is immediately operational once the power is restored.

A special-featured intercom is provided for further scientific use. This system has stations located on the bridge, in all laboratories, on the working deck and at the winch control console. In addition, a transportable intercom station can also be used in a laboratory container. This system permits everybody to communicate with each other. As a result, voice communication via this system can be monitored by all users and anybody can cut in on the conversations as desired.

Radio equipment

All the radio equipment is supplied and installed by the firm of Hagenuk and the firm of IBAK. It consists essentially of the following units:

- AC/DC short-wave radio telephone, type Scanti TRP 8750 with 750 W PEP and fully automatic antenna coupler.

- Radio teletype unit, type FFS 1004 for the SITOR procedure

- Multi-band receiver, type RX 1002

- Weather maps receiver/plotter, type Rayfax 1000

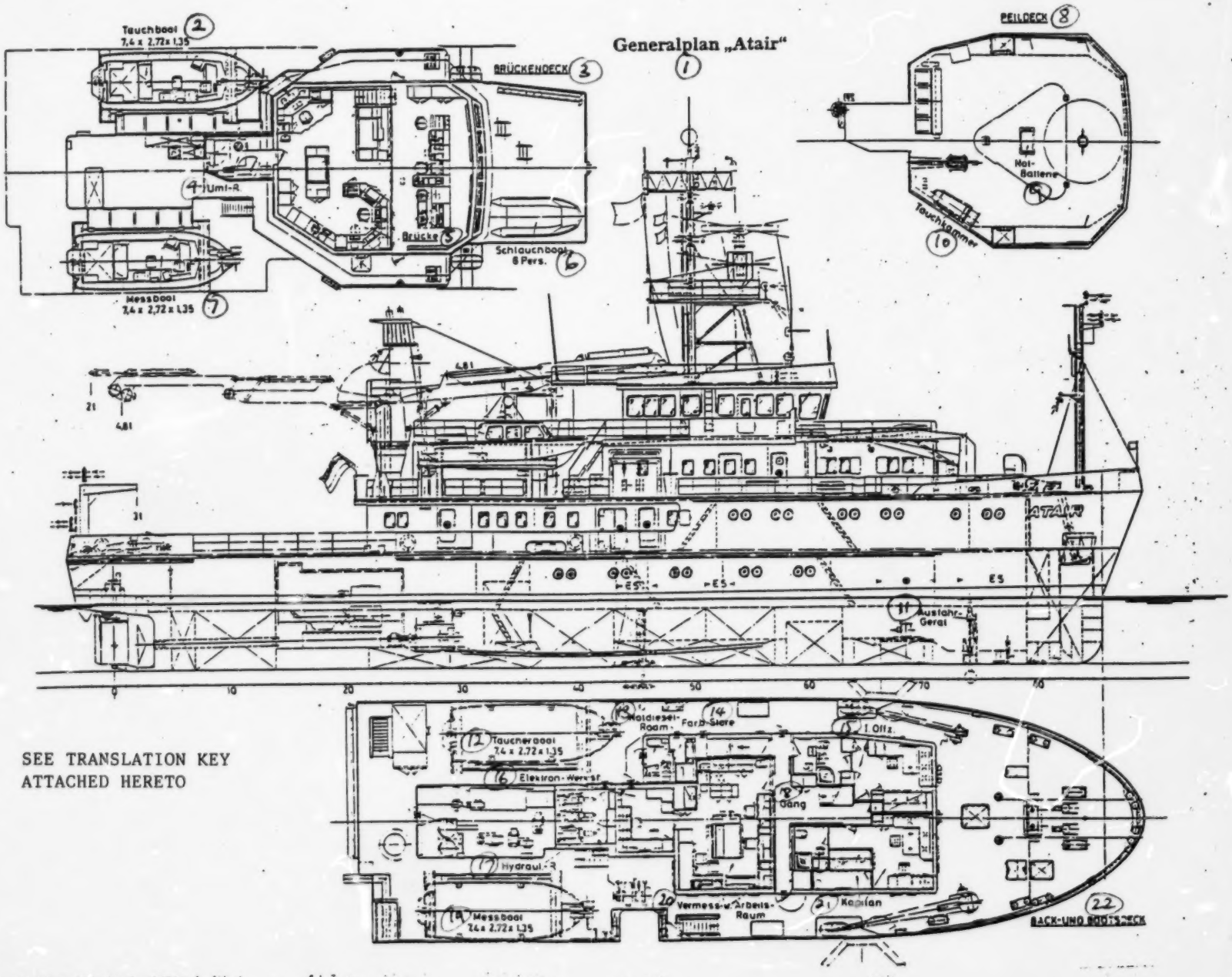
- 2 VHF marine radio installations, type USE 199 D

- AC/DC watch receiver, Navtex receiver and lifeboat radio station.

A CQM 9113 D system supplied by the firm of Storno is installed to permit the vessel to receive and participate in the traffic control radio signals put out by the Marine Board Administration.

Some additional radio equipment is provided for internal communications between the mother ship and the survey boats. It is also possible, by means of a radio interrogation device, to interrogate the existing radio-type water gauges in the North Sea so that the measured water depths can be input on board.

Generalplan „Atair“ (1)



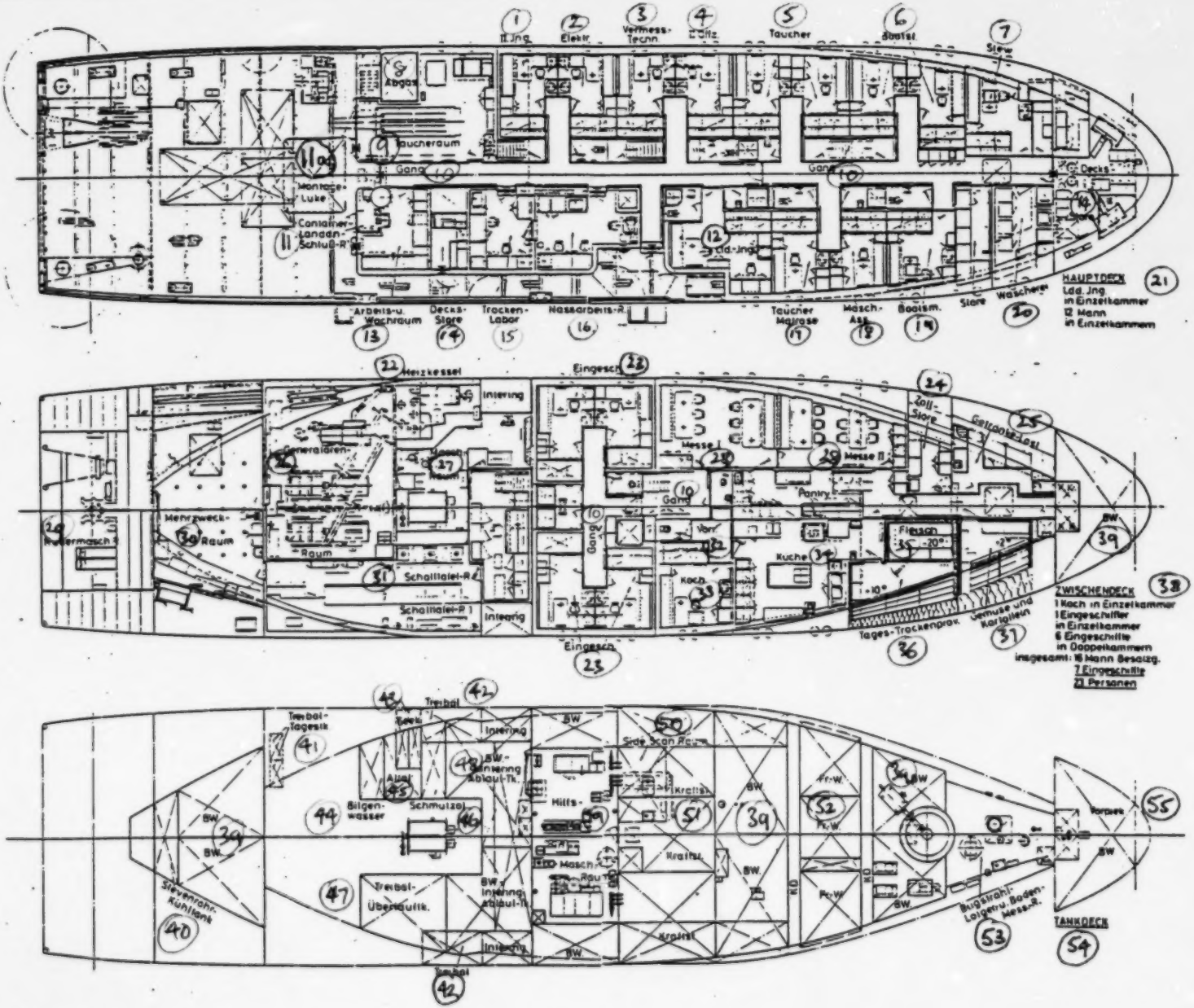
SEE TRANSLATION KEY
ATTACHED HERETO

A

Translation key:

1. General plan of the "Atair"
2. Diver support boat
3. Bridge deck
4. Transformer space
5. Bridge
6. Rubber dinghy for 6 persons
7. Measuring/survey boat
8. Compass bridge/wheelhouse top
9. Emergency (standby) battery
10. Diving (compression) chamber
11. Extending arm
12. Diver support boat
13. Standby diesel room
14. Paint store
15. First Officer
16. Electronics workshop
17. Hydraulic machinery room
18. Gangway/corridor
19. Measuring/survey boat
20. Survey and work room
21. Captain
22. Forecastle and boat deck

SEE TRANSLATION KEY ATTACHED HERETO



Translation key:

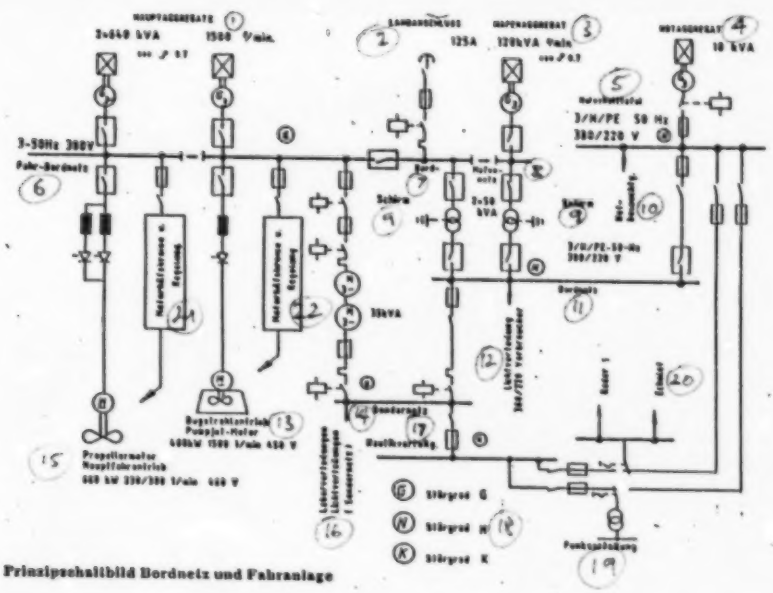
1. Second Engineer
2. Electrician
3. Survey technician
4. Second Officer
5. Divers
6. Coxswain
7. Steward
8. Exhaust (waste air/gas) outlet
9. Diver's compartment/room
10. Alleyway/corridor
11. Container/shore connection room

11a. Assembly access hatch

12. Chief Engineer
13. Work room and watchroom
14. Deck store
15. Dry laboratory
16. Wet work room
17. Diver/seaman
18. Assistant Engineer
19. Boatswain
20. Laundry
21. Main Deck
    Chief Engineer
    in single cabin
    12 men
    in single cabins
22. Heating boiler
23. Non-crew [e.g. scientists]
24. Customs store (bonded storage space)
25. Drinks storage
26. Generator room
27. Engine room
28. Mess room I and II
29. Steering engine (gear)
30. Multi-purpose room
31. Switchboard room
32. Stores/provisions
33. Cook
34. Galley
35. Meat storage (refrigerated storage)
36. Daily rations, dry
37. Vegetables and potatoes
38. Tween deck
    1 cook in single cabin
    1 non-crew members
    in single cabin
    6 non-crew members
    in double cabins
    Total: 16 crew
    7 non-crew
    23 persons
39. Ballast water (??)
40. Stern tube cooling tank
41. Fuel oil tank, day's supply
42. Fuel oil
43. Sea chest
44. Bilge water
45. Waste oil (old oil)
46. Dirty oil
47. Fuel oil overflow tank
48. Ballast water, Intering [stabilizer] overflow tank
49. Auxiliary machinery room
50. Side scan room
51. Fuel
52. Fresh water
53. Bow thruster, echo sounder and contour measuring room

54 Tank deck

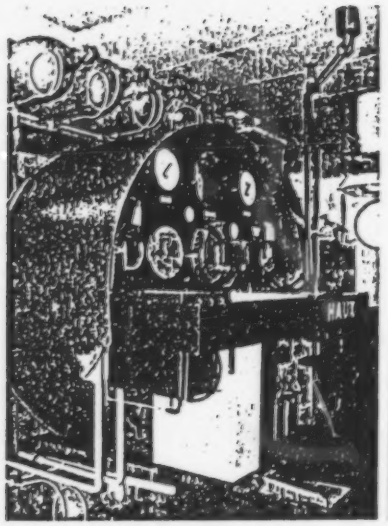
55. Forepeak BW = ballast water (??)



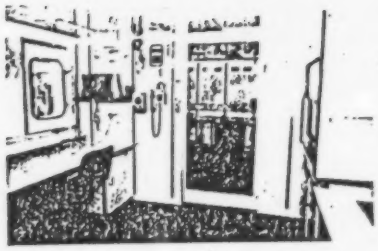
Circuit diagram of the shipboard power supply system and propulsion system

Translation key:

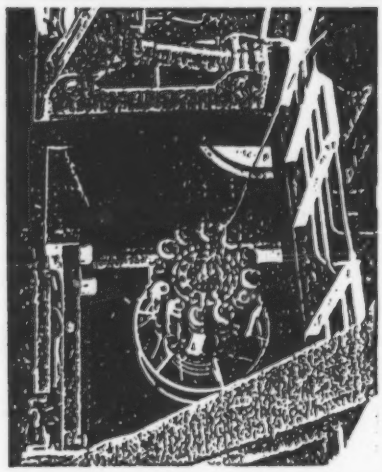
1. Main generating sets
2. Shore connection
3. In-port generating set
4. Standby generator
5. Emergency switchboard
6. Ship's propulsion network
7. Shipboard network
8. In-port network
9. Screen
10. Emergency lighting
11. Shipboard network
12. Lighting distribution system, 380/220 loads
13. Bow thruster drive, pump-jet motor ....
14. Special network
15. Propeller motor, main drive ....
16. Power distribution ot laboratories, lighting distribution system (special network)
17. Power distribution to nautical instrumentation
18. Interference level....
19. Power distribution to radio equipment



Divers' room with decompression chamber

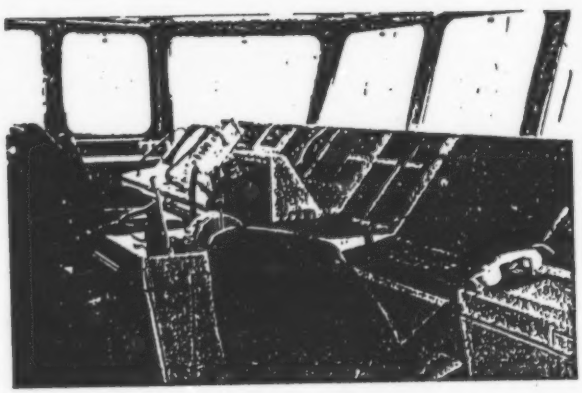


Wet work room and dry laboratory

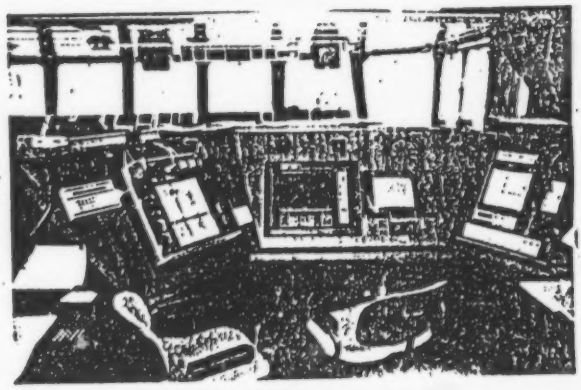


Circular array of water scoops positioned on the working deck in front of the wet work room

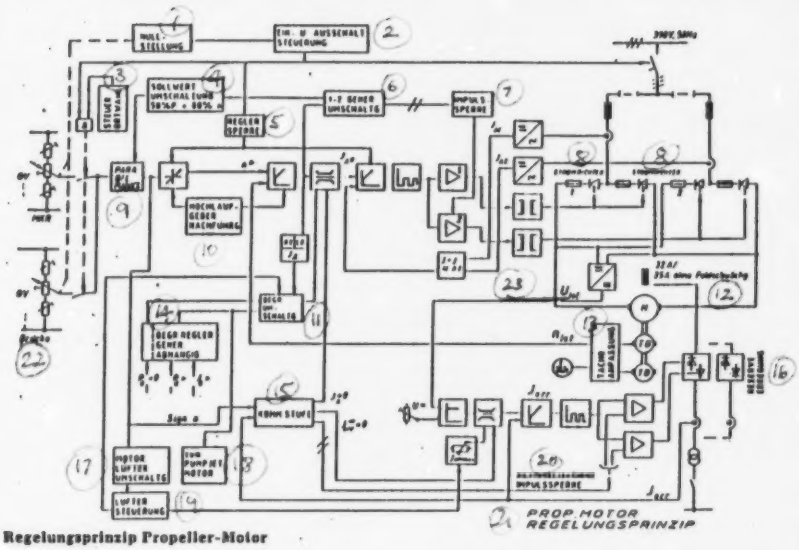
Surveying and general work boat, built by Fassmer



Bridge control stand



Survey control stand, with survey sounder, horizontal echo sounder, and side scan sonar

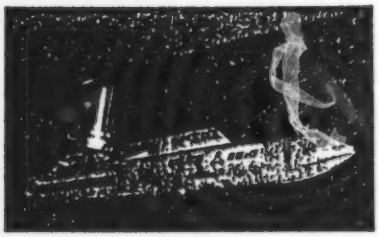


Regelungsprinzip Propeller-Motor

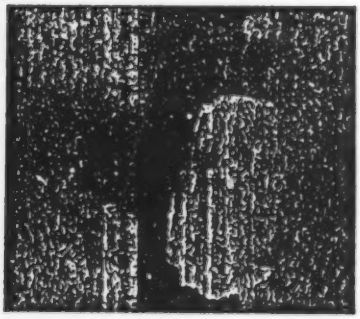
Diagram of propeller motor control circuit

Translation key:

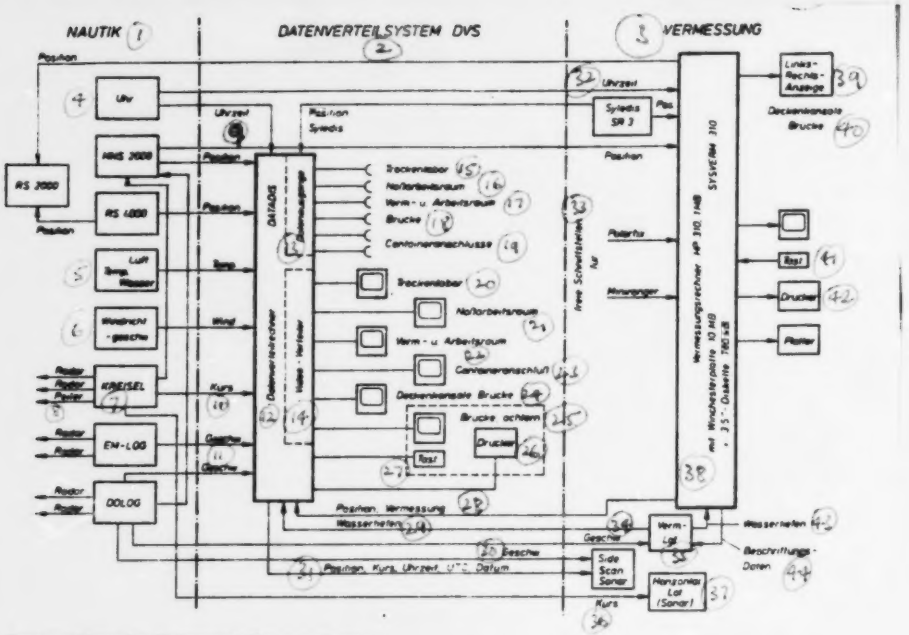
1. Zero position/neutral position
2. On/off control
3. Selection of control point
4. Set-point selection (change-over)
5. Controller lock-out
6. 1-2 generator selection (chage-Over)
7. Pulse inhibitor
8. Converter
9. Parabolic function
10. Ramp correction module
11. Current limiting controller (change-over)
12. ... without field suppression
13. Tacho adjustment
14. Generator-dependent current limiting controller
15. Sequential logic module
16. Reserve excitation
17. Motor fan controller (change-over)
18. to pum-jet motor
19. Fan control
20. Direction-dependent pulse inhibitor
21. Control circuit diagram for propeller motor
22. Bridge
23. ist = actual



The "fish" of the side scan sonar system is extended from a niche in the ship's bottom and reaches down as much as one metre below the keel



Side scan sonar plot of the position of a known wreck



Systemskizze des Datenverteilungssystems

Sketch of the data distribution system

Translation key:

1. Nautical instrumentation
2. Data distribution system
3. Surveying
4. Clock/chronometer
5. Temperature of air and water
6. Direction and speed of wind
7. Gyro
8. Direction finder
9. Time
10. Course
11. Speed
12. Data distribution computer
13. Data outputs
14. Video distributor
15. Dry laboratory
16. Wet work room
17. Survey and work room
18. Bridge
19. Container connections (hook-ups)
20. Dry laboratory
21. Wet work room
22. Survey and work room
23. Container connection (hook-up)
24. Ceiling console, bridge
25. Bridge, aft
26. Printer
27. Keyboard
28. Position, surveying
29. Water depths
30. Speed
31. Position, course, time, UTC, date
32. Time
33. Free interfaces for ....
34. Speed
35. Survey sounder
36. Course
37. Horizontal echo sounder (sonar)
38. Survey computer .... with
    Winchester disk ....
    and .... floppy disc
39. Left-right display
40. Ceiling console, bridge
41. Keyboard
42. Printer
43. Water depths
44. Lettering/labelling data